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Exchange market pressure, stock prices, and commodity prices east of the Euro

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Abstract

Aim/purpose – This paper aims to examine connections between the exchange, equity, commodity and commodity markets of a set of Central and Eastern European (CEE) economies using monthly time-series data. In particular, we examine whether stock – or commodity – price changes might put pressure on these currencies to depreciate, and whether these pressures are transmitted within the region or from larger neighbors.

Design/methodology/approach – This paper creates monthly indices of Ex-change Market Pressure (EMP) from 1998 to 2017 using a combination of currency depreciation, reserve losses, and changes in interest-rate differentials for the Czech Republic, Hungary, Poland, and Ukraine, Bulgaria, and Romania. After examining these indices for evidence of currency 'crises', and their components for evidence of changes in currency policy, Vector Autoregressive (VAR) methods such as Granger causality and impulse-response functions are used to examine connections between EMP, domestic and foreign stock returns, and changes in commodity prices in the first four countries listed.

Findings – While EMP increased in 2008, and the degree of central banks' currency-market interventions decreased afterward, this paper uncovers key differences among countries. In particular, the Czech Republic is relatively insulated from international transmissions, while Hungary is more susceptible to global spillovers and Poland is exposed to events originating elsewhere in the CEE region. Ukraine shows bidirectional causality between its EMP and stock indices, and finds that pressure on the hryvnia increases if commodity or oil prices decline.

Research implications/limitations – This study adds to the relatively limited literature regarding this region, and highlights particular vulnerabilities for both individual countries and specific neighbors; further research is necessary to uncover the channels of transmission using economic modeling.

Originality/value/contribution – This study explicitly models two major economic processes in a part of the world that is relatively rarely examined. These include events in Central and Eastern European exchange markets and central bank intervention, and also interlinkages among regional currency and equity markets, foreign equity markets, and global commodity prices. This will allow policymakers to assess integration between these countries, the rest of the European Union, and the global economy.

Keywords: exchange market pressure, stock returns, commodity prices, Central and Eastern Europe, time series.
JEL Classification: F42, E44, F62, O57.

1. Introduction

While it was originally intended that the Central and Eastern European (CEE) countries that joined the European Union in 2004 and 2007 would soon join the Eurozone, this has not been the case for the majority of these nations. Only the three relatively small Baltic nations, as well as Slovenia and Slovakia, have acceded to the common currency. Major regional economies, including Poland and Hungary, still maintain some degree of floating exchange rates and inflation-targeting as a monetary policy objective. Ukraine's hryvnia has experienced sharp declines, although policymakers have tried to defend it.

At the same time, we would expect that these nominally independent currencies would still be closely connected to events in the Eurozone, as well as elsewhere in the region and in the world. In particular, shocks to stock and commodity prices might spill over to these CEE exchange markets. The impact of these spillovers, particularly those that can be described as intraregional, EU-based, or originating in Russia or the rest of the world, might be stronger for certain countries than for others. These differences must be empirically tested.

Many previous studies in the literature (for example, Connolly & Da Silveira, 1979; Tanner, 2000) focus on emerging markets outside of the CEE region, and few if any examine linkages among markets in these countries. As an important part of the world – particularly in light of the 2008 crisis and its impact on the Euro – the CEE region is worthy of significant attention. This study therefore has two objectives. First, we create time-varying monthly indices of Exchange Market Pressure (EMP) for six CEE currencies and examine their statistical properties. For the four countries for which sufficient data are available, we also examine relationships among EMP; German, Russian, and U.S. stock returns; and various world commodity and energy prices. Overall, we find evidence of spillovers, but with Hungary more susceptible than is the Czech

Republic, for example. Ukraine, with its current crisis, appears to be a major source of shocks to elsewhere in the region and the world.

This paper proceeds as follows. Section 2 surveys the literature. Section 3 outlines the empirical methodology. Section 4 describes the results, and Section 5 concludes.

2. Literature review

Because not all currency crises result in large devaluations, the concept of Exchange Market Pressure (EMP), popularized by Girton & Roper (1977), captures a country's loss of foreign exchange reserves as its central bank defends its currency. Changes in interest differentials (which also are used to defend currencies) have also been included more recently. While the precise derivation of the weighting scheme for the three components has been the subject of some debate, the model-dependent approach introduced by Weymark (1997, 1998) and simple standard deviations are most commonly applied. Van Poeck, Vanneste, & Veiner (2006, 2007), Stavárek (2011), and Heinz & Rusinova (2015) have used this measure to examine the CEE region. General applications of this index have been used in identifying 'crisis' periods, estimating the determinants of these crises or on EMP itself, or testing for spillovers among exchange, asset, or commodity markets.

While these analyses have been conducted for wide varieties of developed economies of emerging markets, relatively few have been conducted solely on CEE countries. Phylaktis & Ravazzolo (2005), for example, find a strong connection among stock prices and exchange rates in the Pacific Basin, with U.S. stock market exhibiting a strong influence. Many studies of the CEE region focus solely on either currency or stock markets, but generally find evidence of spillovers. Hegerty (2009), for example, uses Generalized Vector Autoregressive (VAR) methods to show that EMP, particularly in countries such as Latvia and Hungary that were hit hard by the financial crisis, are transmitted to the others among the seven countries in the sample. Harkmann (2014) uses Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models to examine volatility spillovers from Western Europe to eight CEE countries, and find correlations to be increasing over time.

Studies that examine two types of markets also find evidence of spillovers, with stock markets having stronger effects on exchange markets than vice versa. Most, however, examine exchange-rate returns rather than any measure of market pressure. Ülkü & Demirci (2012) examine stock-price and exchange-rate returns in seven CEE countries (as well as Turkey) using VAR methods and find significant impulse responses. The authors attribute much of this transmission to be due to global markets, confirming the findings of Phylaktis & Ravazzolo (2005). Koseoglu & Cevik (2013) show that stock markets Granger-cause changes in exchange rates in the Czech Republic, Hungary, and Turkey. Hegerty (2014) examines 10 emerging markets, including Croatia, Poland, and Russia, and finds these latter two countries to be important sources of shocks to regional EMP and stock indices.

The role of commodity prices – particularly energy prices – has been given even less attention in the literature. Mensi, Beljid, Boubaker, & Managi (2013), for example, examine spillovers among various stock and commodity indices, and the concept of 'commodity currencies' introduced by Cashin, Céspedes, & Sahay (2002) is well known, but country-specific investigations of connections among commodity prices, market pressure, and stock indices are rarer. It is expected that declines in world commodity and energy prices can put pressure on currencies to devalue or result in domestic stock-price declines, and that the same can occur with major stock-price movements. At the same time, stock prices and EMP can affect each other within a country or regionally.

The main channels through which currency, equity, and commodity markets interact involve capital flows (financial linkages), trade flows (real linkages), and investor behavior (psychological channels). Within a country, stock-price declines might encourage investors to withdraw capital from the entire economy, putting pressure on the currency to depreciate. A reduction in profitability could also affect the country's exports, leading to a similar impact on the exchange rate. Such economic events might be augmented by investor 'panic' or portfolio rebalancing, as investors react (irrationally) to losses in one country by selling off more assets, or compensate for losses in stocks by (rationally) selling currency. Among countries, these same channels might allow for international transmission, particularly through the export channel as currencies rise and fall, and could also be intensified if investors view the CEE region as a unified whole and (for example) sell Polish assets based on events in Ukraine.

Commodity prices might have similar effects as stock prices, and energy prices in particular can also have real effects on firms' costs or revenues. A drop in oil prices, for example, might lower Polish costs but hurt export partners such as Russia. It might also reflect a drop in global demand. These effects would therefore have an indeterminate effect on the złoty and on Polish firms.

These linkages might work in the opposite direction if currency declines encourage investors to abandon a country's stocks, but it is not expected that small countries' currency markets, for example, could have an impact on U.S.

stock prices or world oil prices. The fact that some spillovers might be bilateral and others will be unilateral affects our choice of model structure and responses of interest.

It is therefore necessary to analyze these spillovers empirically, particularly for the important region of Central and Eastern Europe. This study conducts such an analysis, constructing EMP indices for Bulgaria, Romania, Czech Republic, Hungary, Poland, and Ukraine, and examining linkages among EMP, stock prices, and commodity and energy prices for the latter four countries. This is not only interesting for practitioners within the region, but for policymakers worldwide who can learn from its experience.

3. Research methodology

Using monthly data from the International Financial Statistics of the International Monetary Fund over the period from 1998 to early 2017, we first create Exchange Market Pressure (EMP) indices out of three components. Following Eichengreen, Rose, & Wyplosz (1996), these include monthly log changes in the nominal exchange rate (local currency per U.S. dollar), monthly reserve losses (changes in *RES*, scaled by a deseasonalized measure of the narrow money supply), and changes in the short-term interest-rate differential vis-à-vis the United States:

$$EMP_t = \frac{1}{\sigma_{\Delta e}}\left(\ln e_t - \ln e_{t-1}\right) - \frac{1}{\sigma_{\Delta RES}}\frac{\Delta RES_t}{Money_{t-1}} + \frac{1}{\sigma_{\Delta r}}\Delta\left(r_t - r_t^{US}\right) \tag{1}$$

As is standard in the literature, each component is normalized by its own standard deviation so that the most volatile part does not dominate the index. Pentecost, Van Hooydonk, & Van Poeck (2001), Kumah (2007), Pontines & Siregar (2008), Bertoli, Gallo, & Ricchiuti (2010), and Hegerty (2013) discuss alternative choices of weights, but this method is most common in the literature.

While this continuous index can ‘spike’ during a crisis (often defined as periods during which the index exceeds 1.5 times its series mean), it includes non-crisis periods as well. This allows us to assess events during ‘normal’ periods, as well as those where currencies face pressure to appreciate (which would be represented as negative EMP values).

The ‘mix’ of policy responses (or non-responses) can change over time, however. Patnaik, Felman, & Shah (2017), for example, develop an empirically applicable index of EMP and measure the effectiveness of interventions, and Blanchard, Adler, & de Carvalho Filho (2015) assess the effectiveness of interventions in the face of international capital flows. An exchange rate might at times be allowed to depreciate, while at other times, a central bank might intervene. This is captured by changes in the EMP components' relative volatilities, which is calculated with rolling variance ratios over 12-month windows:

$$Var.Ratio_t = \frac{\sigma^2_{E,t:t-11}}{\sigma^2_{RES,t:t-11} + \sigma^2_{DelRdiff,t:t-11}} \tag{2}$$

As we see below, exchange-rate changes dominate during certain periods, highlighting a less-active central bank. We also identify structural breaks in both the EMP series and the variance ratios via the Bai–Perron (Bai, & Perron, 1998) test (minimizing the Akaike Information Criterion), which will allow us to identify months during which policy may have changed.

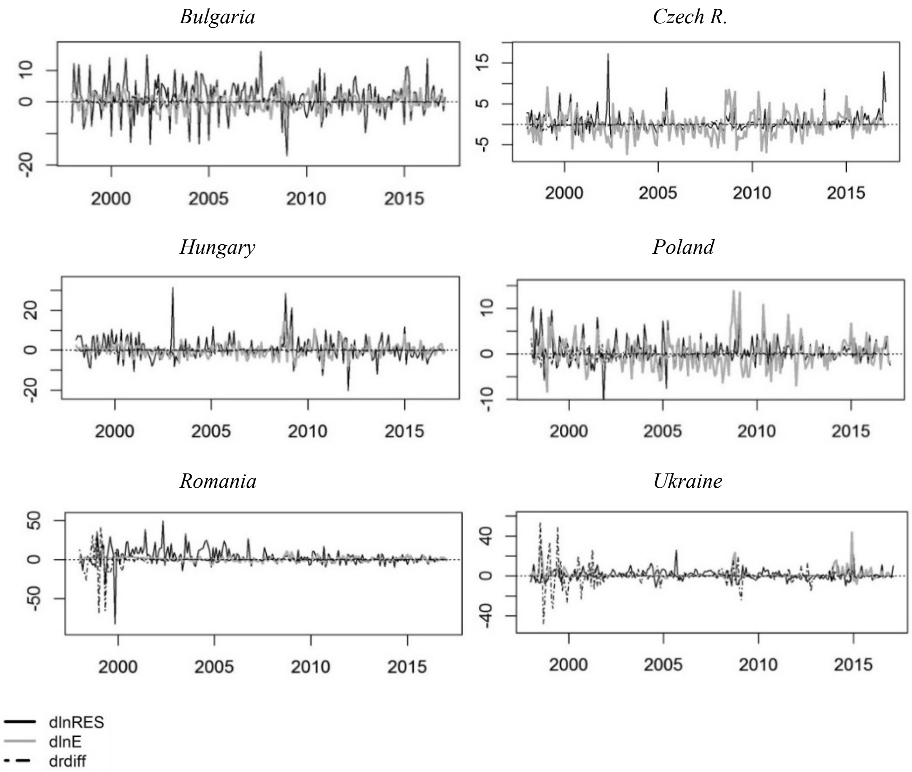
Next, we estimate connections among EMP and various stock and commodity prices. We measure monthly log changes in four of the six countries' stock price indices; German, Russian, and U.S. stock price indices; a general commodity price index; and indices of natural gas and oil (U.K. Brent) prices. All commodity price indices are taken from the St. Louis Federal Reserve FRED database, as are Hungarian and German equity price indices. The remaining stock price indices are taken from the IFS. We first calculate simple pairwise correlations, and then calculate rolling Spearman correlations (over 12-month windows), between EMP and these stock and commodity prices. This will show periods during which connections are strongest.

Finally, we conduct VAR analyses using vectors of EMP indices, stock prices, and commodity prices. This is done using the orthogonalized methodology of Sims (1980). For each of the four countries, we estimate a four-variable VAR, with lag lengths chosen by minimizing the Schwarz Criterion and the variables ordered as Commodity Price → Foreign Stock Price → Domestic Stock Price → Domestic EMP. This follows a traditional Cholesky ordering, from most to least exogenous. We expect, for example, that world commodity prices might affect Poland's EMP, but not vice-versa. We also surmise that Polish stock prices are more likely to affect the currency, but that the effects might be bilateral; we therefore choose this order of variables, but test both directions of causation. We also re-estimate each model using each foreign stock price. As an additional test, we conduct pairwise Granger Causality tests for all pairs of variables, including cross-country, intraregional combinations. Our results are provided below.

4. Research findings

Figure 1 depicts the three EMP components for all six countries. We find that exchange-rate movements are generally relatively large, but that in some cases (such as Romania early on), reserves tend to be more variable. This suggests differences in monetary and intervention policy, which we explore in more detail below.

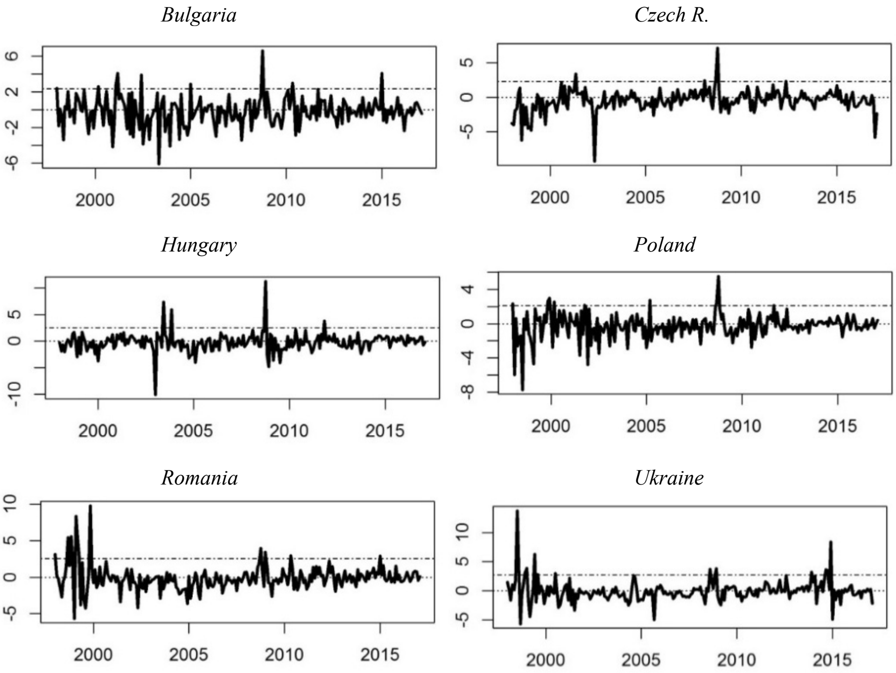
Figure 1. Exchange Market Pressure Components, 1998-2017



Source: Author's calculation.

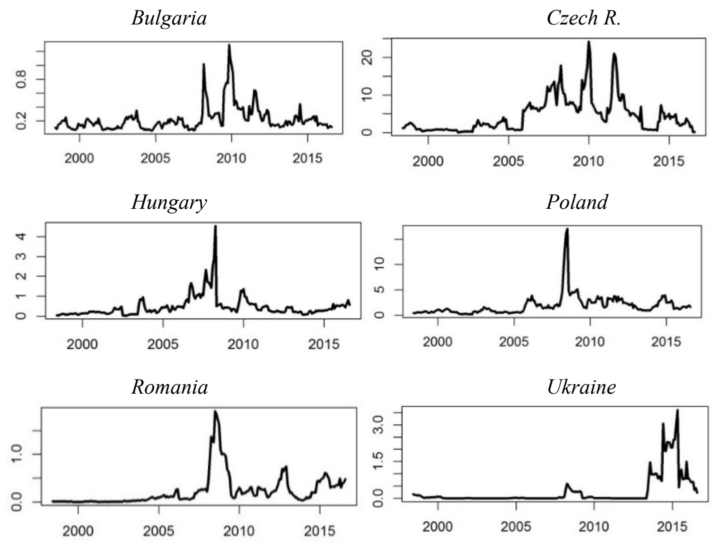
The EMP indices that are created from these components are next presented in Figure 2. As would be expected during the global financial crisis, EMP 'spikes' in 2008 for all countries. We also see other periods of high pressure; such as during the early 2000s for all the countries. To see whether this pressure was driven through depreciation or intervention, we examine the variance ratios in Figure 3. For the most part, interventions were successful, since low ratios suggest larger variances in reserve changes or interest-rate changes. But, around the time of the 2008 crisis, exchange-rate volatility became relatively large. These changes persisted for some countries, particularly for the Czech Republic, but also for Bulgaria and Romania, well into the next decade. Ukraine's variance ratio increased drastically at the onset of the current crisis.

Figure 2. Exchange Market Pressure indices (with +1.5 SD 'crisis' lines), 1998-2017



Source: Author's calculation.

Figure 3. Variance ratios (rolling, with 12-month windows), 1999-2017



Source: Author's calculation.

Table 1 presents summary statistics for all variables calculated in this study, and Table 2 provides the structural break dates in all the EMP and variance ratios. Not all EMP series are subject to these breaks, but they are found in late 2000 for the Czech Republic and Romania, with an additional break in Romanian EMP in 2007. All six variance ratios have at least one structural break. These occur post-EU accession, signifying a change in policy. There are breaks in 2005 for the Czech Republic, Hungary, and Poland, and in 2007 in Romania and 2008 in Bulgaria. While not part of the EU, Ukraine does show a structural break in 2013. Table 2 also presents months that can be defined as ‘crises’, during which EMP exceeds 1.5 (or 2, if a stricter definition is applied) standard deviations above the series mean. As expected from Figure 2, there were currency ‘crises’ for all countries during late 2008. Country-specific episodes include the Bulgarian inflation episode in 1998; late 1990s Poland, Romania, and Ukraine; and early 2000s Czech Republic, Hungary, and Bulgaria.

Table 1. Summary statistics

EMP Indices	BU	CZ	HU	PL
1	*2*	*3*	*4*	*5*
Min	−6.082	−9.205	−10.027	−7.702
Med	−0.148	−0.328	−0.101	−0.232
Mean	−0.192	−0.459	−0.2	−0.265
SD	1.549	1.535	1.691	1.413
Max	6.564	7.082	11.206	5.495
Var. Ratio	BU	CZ	HU	PL
Min	0.06	0.129	0.032	0.166
Med	0.167	2.907	0.313	1.41
Mean	0.224	4.478	0.458	1.882
SD	0.183	4.554	0.512	2.037
Max	1.291	24.105	4.525	16.992
Stock Prices	CZPS	HUPS	PLPS	UAPS
Min	−0.312	−0.42	−0.235	−0.403
Med	0.004	0.011	0.014	0.004
Mean	0.003	0.007	0.006	0.005
SD	0.058	0.068	0.057	0.118
Max	0.19	0.262	0.163	0.402
EMP Indices	RO	UA		
Min	−5.637	−5.663		
Med	−0.188	−0.169		
Mean	−0.101	−0.025		
SD	1.695	1.828		
Max	9.76	13.684		
Var. Ratio	RO	UA		
Min	0.001	0		
Med	0.102	0.003		
Mean	0.225	0.264		
SD	0.33	0.609		
Max	1.904	3.595		
Stock Prices	USPS	DEPS		
Min	−0.192	−0.234		
Med	0.009	0.011		

Table 1 cont.

1	*2*	*3*	*4*	*5*
Mean	0.004	0.003		
SD	0.037	0.052		
Max	0.099	0.13		
World Prices	RUPS	PC	POILB	PNG
Min	−0.424	−0.236	−0.311	−0.407
Med	0.017	0.01	0.017	−0.005
Mean	0.014	0.003	0.005	0.001
SD	0.103	0.05	0.095	0.133
Max	0.467	0.111	0.201	0.479

Source: Author's calculation.

Table 2. Structural break dates and 'crisis' periods

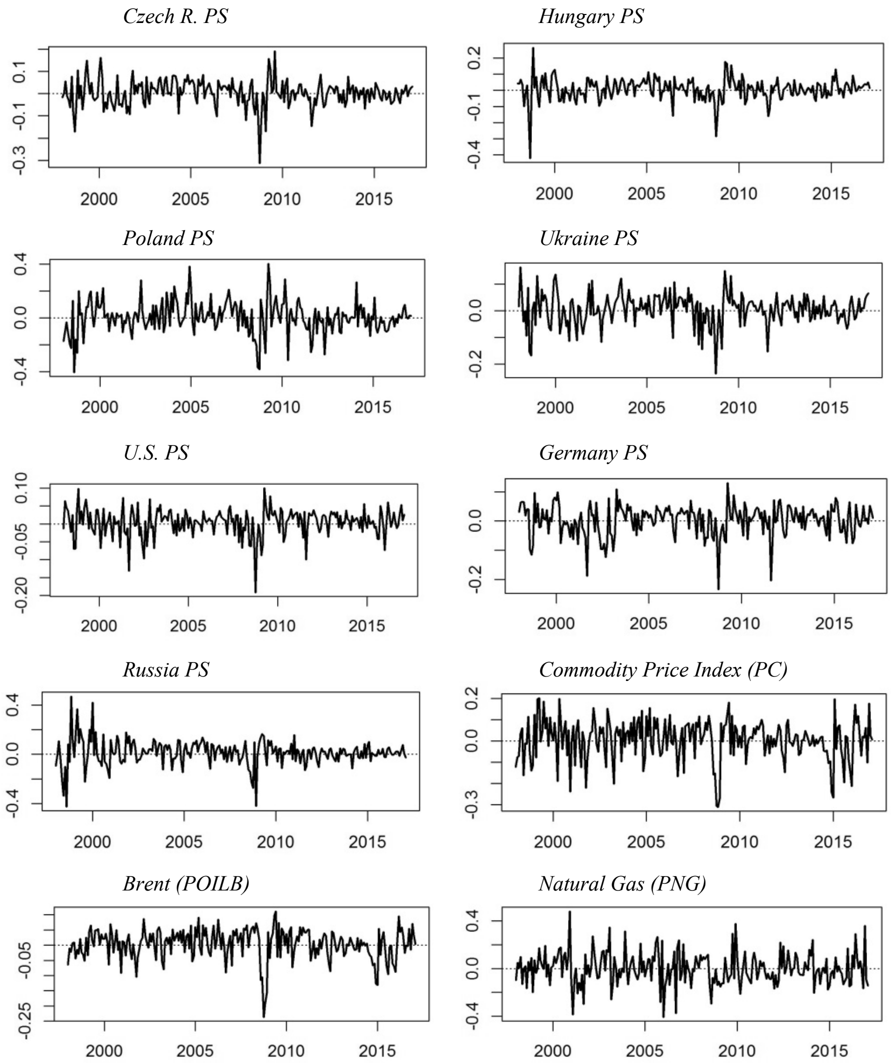
	EMP Structural Breaks	Variance Ratio Breaks
BU	NA	2008(2) 2011(11)
CZ	2000(12)	2005(11) 2012(5)
HU	NA	2005(12) 2008(8)
PL	NA	2005(6) 2008(2) 2010(10)
RO	2000(10) 2007(7)	2007(6) 2010(2)
UA	NA	2013(6)
	'Crises' (bold = > 2 s.d.)	
BU	1998(1) 2000(3) **2001(3) 2002(6)** 2005(1) **2008(10)** 2010(5) 2015(1)	
CZ	**2001(5)** 2008(2) **2008(10)**	
HU	**2003(6) 2008(10) 2011(11)**	
PL	1998(1) **1999(12)** 2001(10) 2005(3) **2008(10)**	
RO	1998(1) **1998(9) 1999(11) 2008(10)** 2010(5) 2015(1)	
UA	**1998(7) 1999(6)** 2000(7) **2008(8)** 2013(12) **2014(12)**	

Source: Author's calculation.

Turning next to changes in domestic and global stock commodity prices, which are expected to be connected to currency pressures, we examine Figure 4 and see sharp drops in all return series during 2008. We also see higher volatility later in the sample, and other periods of sharp increases or decreases. Commodity prices appear more volatile than stocks, which is confirmed in Table 1, where natural gas prices have a higher variance than all stock prices, and oil prices are more variable than all but Russian and Ukrainian stock prices.

There are strong relationships among stock returns and commodity indices between countries. Simple correlations among measures, provided in Table 3, show connections among Czech, Hungarian, and Polish stock prices to be high. German stock prices are also strongly linked to the CEE EU members, but Russian stock prices are more closely connected to Ukraine. Our general commodity price index has higher correlation coefficients than do oil or natural gas prices.

Figure 4. Stock and commodity price indices



Source: Author's calculation.

Table 3. Correlations among stock and commodity price indices

	CZPS	HUPS	PLPS	UAPS	USPS
1	*2*	*3*	*4*	*5*	*6*
CZPS	1	0.767	0.752	0.528	0.595
HUPS		1	0.72	0.464	0.627
PLPS			1	0.439	0.641
UAPS				1	0.346
	DEPS	RUPS	PC	POILB	PNG
CZPS	0.699	0.463	0.362	0.264	0.13
HUPS	0.695	0.441	0.309	0.204	0.049
PLPS	0.695	0.432	0.316	0.257	0.064

Table 3 cont.

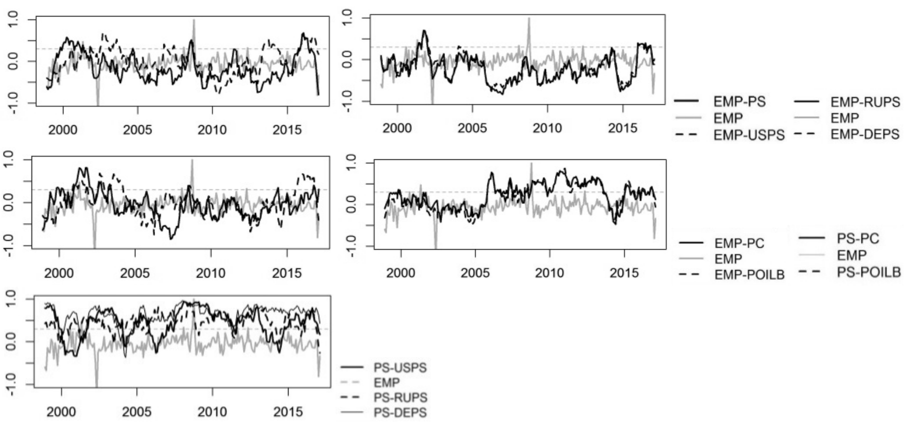
1	*2*	*3*	*4*	*5*	*6*
UAPS	0.415	0.464	0.317	0.245	0.144
USPS	0.781	0.394	0.265	0.183	0.03
DEPS	1	0.412	0.255	0.184	0.039
RUPS		1	0.328	0.302	0.081
PC			1	0.937	0.229
POILB				1	0.17

Source: Author's calculation.

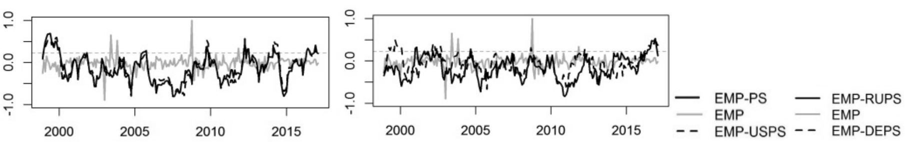
Figure 5 presents rolling correlations between various pairs of EMP, stock prices, and commodity prices, with each country's EMP index superimposed among the correlations. While the different correlations appear tight, moving together over time, there is little obvious pattern to the differences in values over time. EMP 'spikes' do not appear to lead to overall increases or decreases in these correlations.

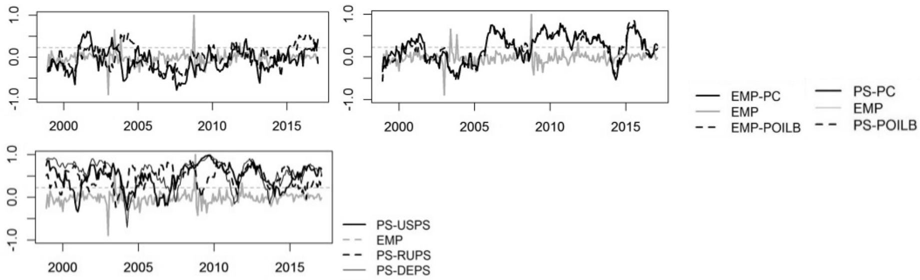
Figure 5. Rolling correlations (12-month windows) with EMP indices and stock-price changes

Czech R.

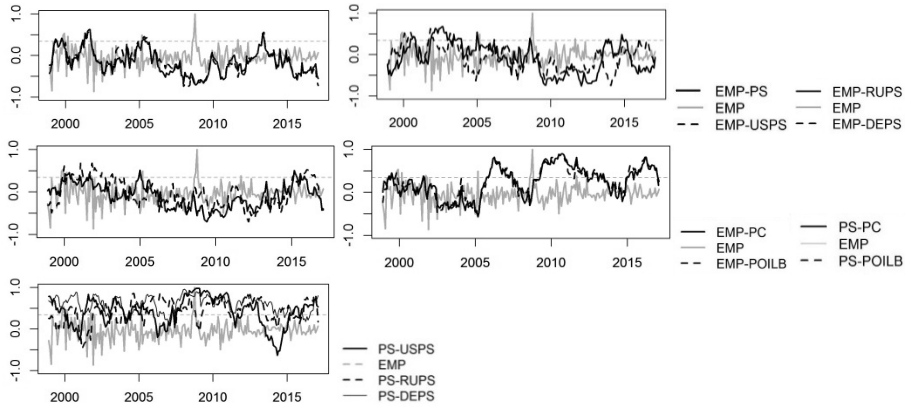


Hungary

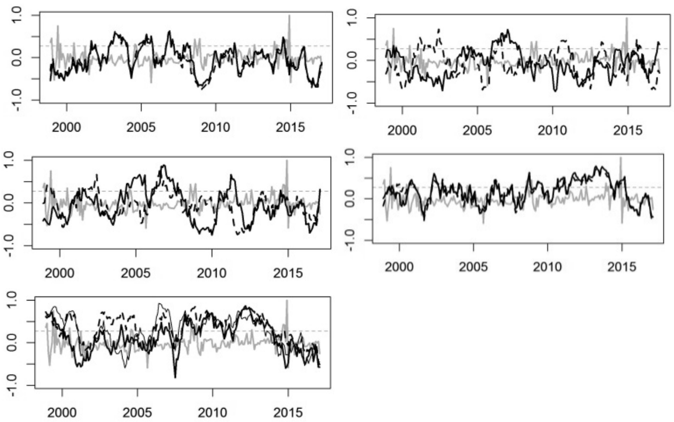




Poland



Ukraine



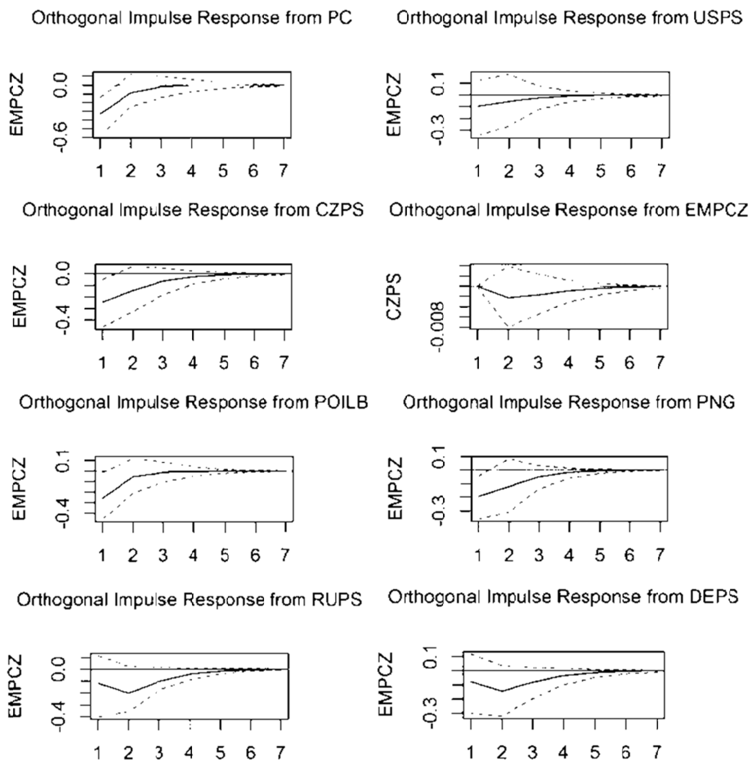
Source: Author's calculation

Many of these EMP increases occur in the middle of a period of rising or falling correlations. There are a few exceptions, where future research could test whether visual appearances are indeed statistically significant. For example, the correlations between domestic stock returns and changes in commodity prices, appear to rise post-2008 in all countries, which follows EMP 'spikes' in the Czech Republic, Hungary, and Poland. This might be attributable to global growth rather to any type of crisis-induced economic change. Nevertheless, certain patterns may be worth exploring, such as Poland's apparent post-2008 'decoupling' between EMP and German and Russian stock returns.

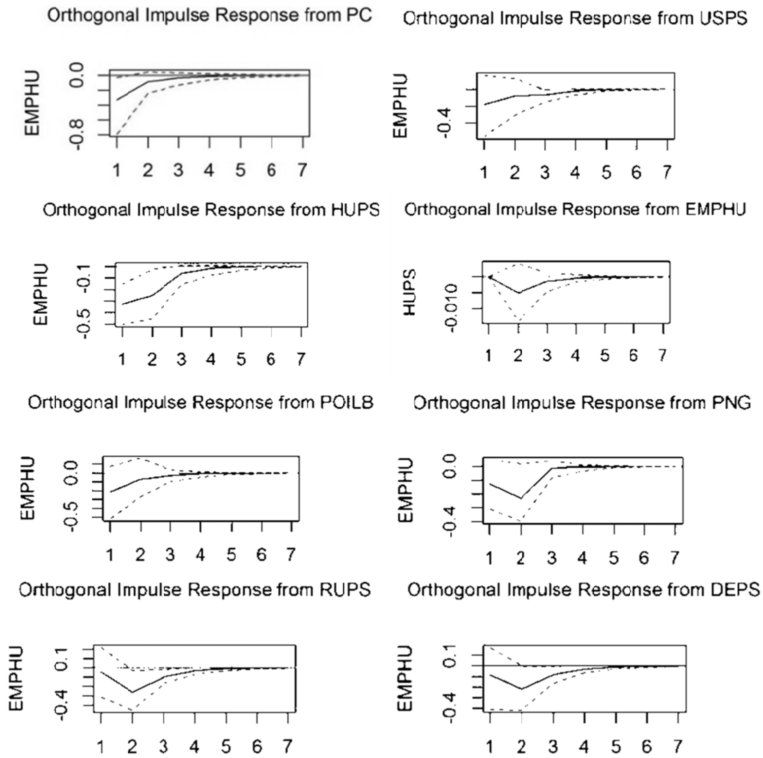
Our key tool of analysis, orthogonalized Impulse Response Functions (at 6-month horizons), are presented in Figure 6. As expected, the effects of various shocks differ from country to country and from variable to variable. The Czech Republic, for example, registers no significant effect to its EMP or stock returns by any of the shocks. In Hungary, on the other hand, decreases in stock prices increase pressure on the forint. The same is true for drops in Russian and German stock prices, as well as in natural gas prices. Poland only experiences similar spillovers from German stock price to the złoty (Russia's effects are only evident via the IRFs, and not confirmed by our Granger causality tests.) In both countries we see financial spillovers from regional economies to domestic currency markets.

Figure 6. Orthogonalized impulse response functions with 95% confidence bands

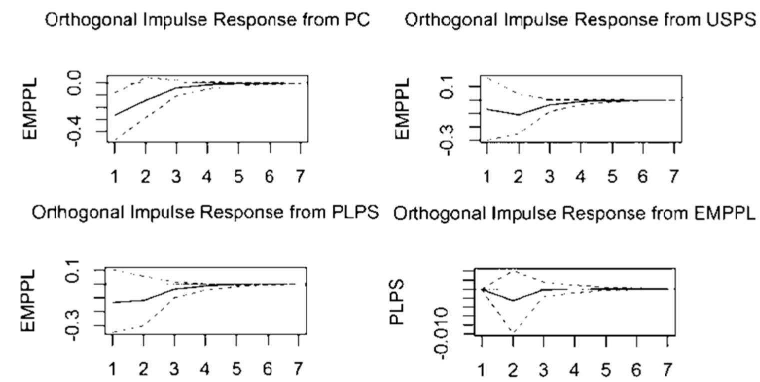
Czech R.

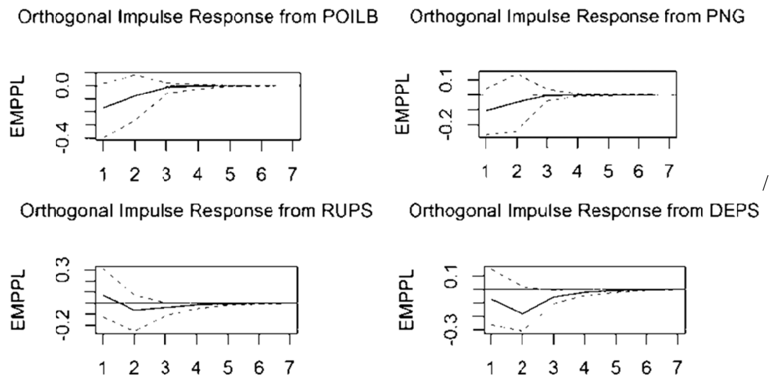


Hungary

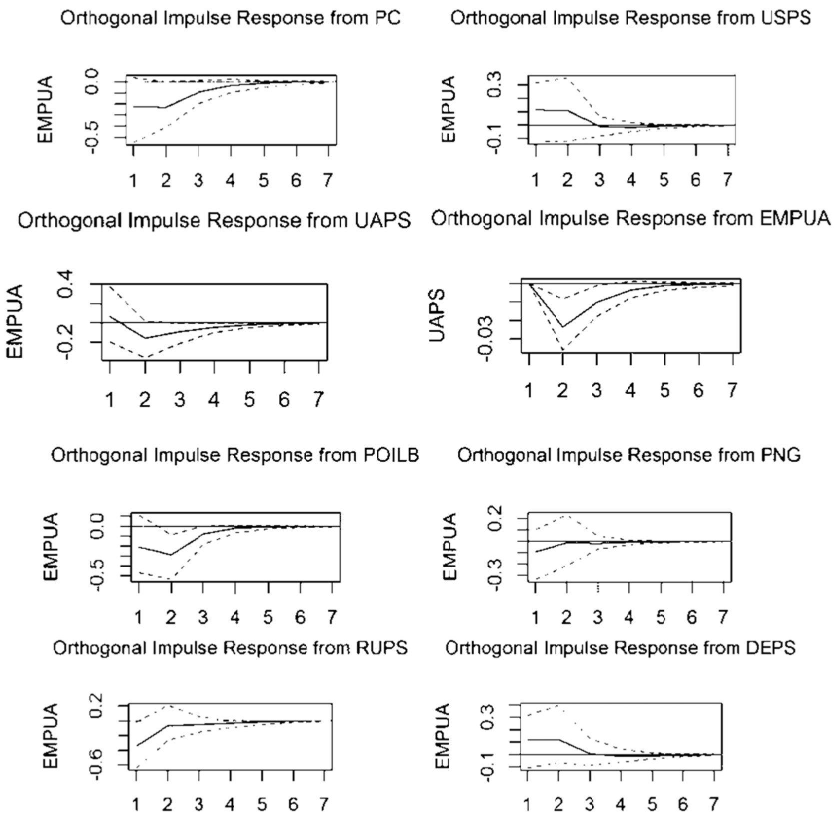


Poland





Ukraine



Source: Author's calculations.

Ukraine experiences domestic as well as regional spillovers. Increases in EMP reduce stock returns, and the reverse is true to a lesser extent (the corresponding Granger Causality test is significant at only 8.6 percent). Likewise, oil price increases reduce EMP, as do increases in the overall commodity price index (with a higher p-value). Perhaps surprisingly, given the role that energy plays in the country's politics, natural gas prices have no significant effect.

The Granger causality test results presented in Table 4 confirm the findings from our impulse-response functions. Ukraine appears to be a significant source of macroeconomic shocks, with spillovers to global − and particularly Russian − stock indices. An additional panel shows cross-country, regional spillovers among the stock returns and EMP indices in our four CEE countries. Polish EMP seems to be susceptible to regional spillovers, and increased pressure on the hryvnia has effects on all three neighbors' stock returns. In addition, Czech stocks and Hungarian EMP have a bilateral effect on each other.

Table 4. Granger causality tests (and p-values)

International			
X	Y	X->Y	Y->X
1	*2*	*3*	*4*
CZPS	EMPCZ	0.223 (0.637)	0.469 (0.494)
USPS	EMPCZ	0.015 (0.904)	1.441 (0.231)
DEPS	EMPCZ	1.362 (0.244)	0.027 (0.869)
RUPS	EMPCZ	2.292 (0.131)	0.072 (0.788)
PC	EMPCZ	0.171 (0.679)	1.582 (0.209)
PNG	EMPCZ	0.310 (0.578)	0.207 (0.649)
POILB	EMPCZ	0.157 (0.692)	1.252 (0.264)
HUPS	EMPHU	**5.293 (0.022)**	1.405 (0.236)
USPS	EMPHU	0.679 (0.411)	0.105 (0.746)
DEPS	EMPHU	**4.607 (0.032)**	0.294 (0.588)
RUPS	EMPHU	**6.562 (0.011)**	1.193 (0.275)
PC	EMPHU	0.553 (0.457)	**11.433 (0.001)**
PNG	EMPHU	**4.256 (0.040)**	0.772 (0.380)
POILB	EMPHU	0.478 (0.490)	**11.139 (0.001)**
PLPS	EMPPL	**5.297 (0.022)**	0.392 (0.532)
USPS	EMPPL	2.749 (0.098)	2.912 (0.089)
DEPS	EMPPL	**6.077 (0.014)**	0.025 (0.874)
RUPS	EMPPL	1.634 (0.202)	2.033 (0.155)
PC	EMPPL	3.132 (0.077)	**5.123 (0.024)**
PNG	EMPPL	0.343 (0.559)	0.489 (0.485)
POILB	EMPPL	0.918 (0.339)	**6.878 (0.009)**
UAPS	EMPUA	2.966 (0.086)	**8.952 (0.003)**
USPS	EMPUA	0.033 (0.855)	**3.968 (0.047)**
DEPS	EMPUA	0.089 (0.765)	2.801 (0.095)
RUPS	EMPUA	0.455 (0.500)	**4.263 (0.040)**
PC	EMPUA	3.490 (0.062)	3.583 (0.059)
PNG	EMPUA	0.000 (0.999)	3.297 (0.070)
POILB	EMPUA	**5.185 (0.023)**	2.604 (0.107)
Within regions			
X	Y	X->Y	Y->X
HUPS	EMPCZ	0.658 (0.418)	0.077 (0.781)
PLPS	EMPCZ	0.525 (0.469)	1.445 (0.230)
UAPS	EMPCZ	0.521 (0.471)	**3.969 (0.047)**
CZPS	EMPHU	**4.785 (0.029)**	**6.207 (0.013)**
EMPCZ	EMPHU	1.943 (0.164)	0.799 (0.372)

Table 4 cont.

1	*2*	*3*	*4*
PLPS	EMPHU	3.253 (0.072)	0.763 (0.383)
UAPS	EMPHU	**13.445 (0.000)**	0.787 (0.375)
CZPS	EMPPL	**5.574 (0.019)**	2.867 (0.091)
EMPCZ	EMPPL	**5.259 (0.022)**	0.304 (0.581)
EMPHU	EMPPL	**8.887 (0.003)**	0.012 (0.915)
HUPS	EMPPL	**6.309 (0.012)**	0.006 (0.940)
UAPS	EMPPL	2.244 (0.135)	1.931 (0.165)
CZPS	EMPUA	0.394 (0.530)	**12.39 (0.000)**
EMPCZ	EMPUA	1.260 (0.262)	0.112 (0.738)
EMPHU	EMPUA	1.632 (0.202)	0.012 (0.914)
EMPPL	EMPUA	0.422 (0.516)	0.124 (0.724)
HUPS	EMPUA	0.012 (0.912)	**13.707 (0.000)**
PLPS	EMPUA	1.489 (0.223)	**10.808 (0.001)**

Note: Bold = significant at 5 percent.

Source: Author's calculations.

5. Conclusions

More than a decade after joining the European Union, many of Central and Eastern Europe's largest economies have yet to join the Euro. While nominally independent, these currencies are expected to be closely connected to European, as well as regional and global, financial markets. In particular, foreign stock returns and world commodity prices are expected to generate spillovers to the CEE region, particularly in ways that can put pressure on domestic currencies to devalue. These spillovers, however, can vary from country to country, depending on the degree of regional integration.

This study tests these conjectures by calculating indices of Exchange Market Pressure (EMP) for five CEE EU members, as well as Ukraine. These continuous indices often reach excessively high levels, which can be further used to identify periods of 'currency crisis'. For four of these countries, we then test for spillovers among EMP, domestic stock returns, foreign stock returns, and commodity and energy prices. Rolling correlations and Vector Autoregressive (VAR) methods confirm that countries' degrees of exposure, both as sources and as destinations of spillovers, vary over time and by country.

In particular, For the EU members, EMP 'spikes' during the 2008 crisis, with currency interventions decreasing after that time. A similar event occurs after 2013 in Ukraine. Among the CEE exchange and stock markets, the Czech Republic appears to be the most insulated from international transmissions, while Hungary is more susceptible to global spillovers. Poland is more exposed to events originating elsewhere in the CEE region. Ukraine shows bidirectional causality between its EMP and stock indices, and finds that pressure on the hryvnia increases if commodity or oil prices decline. German stock prices are linked to the CEE EU members, but Russian stock prices are more closely connected to Ukraine. In general, Poland serves as a key recipient of shocks, while Ukraine is a major source, with effects on Russian stock returns.

Policymakers, therefore, should consider these macroeconomic transmissions when managing their currencies. Understanding the relative strengths of external spillovers will help focus attention on neighboring countries' policies. Those countries that serve as sources of shocks should take into account these external effects of exchange-rate and macroeconomic policy. In particular, mitigating the external impact of events in Ukraine might motivate policymakers to help stabilize the country.

These findings might also be useful to policymakers elsewhere. In particular, the effects of local, regional, and global shocks might be if similar interest in other emerging markets. Asia, for example, might feel conflicting pressures within the ASEAN bloc and from China. At the same time, future work might aim to explore the channels of transmission among currency, equity, and commodity markets in more detail, particularly using economic modeling techniques. In particular, the financial and psychological channels, and the inherent conflicts between the fundamentals behind capital flows and investor psychology, might be of particular interest.

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